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NAVAL SURFACE WARFARE CENTER



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Harnessing the Power of Technology for the Warfighter 

Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE 30 AUG 2011		2. REPORT TYPE		3. DATES COVERED 00-00-2011 to 00-00-2011	
4. TITLE AND SUBTITLE PMP Lessons Learned				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) National Defense University Press, 260 Fifth Ave., Bldg. 64, FT McNair, Washington, DC, 20319				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES Published in the Journal PRISM vol 3, no. 2, 2012					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 17	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



PMP LESSONS LEARNED

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30 AUGUST 2011


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PMP Advisories

- Produced whenever a part, material, or process experiences an unusual failure or problem that can be shared with the community to help avoid future issues and improve system reliability, quality and safety
- Around 10-15 advisories per year covering a wide variety of PMP problems
 - Counterfeit parts
 - Ground Support Equipment issues
 - Safety issues
 - Process problems

SUBJECT: Wind River Embedded Software/Firmware Bugs MDA Hardware	MANUFACTURER: Wind River Systems	PAGE: 1	NO. OF PAGES: 2
PART NUMBER: Vx Works, Tornado	CAGE CODE:	 MDA LESSONS LEARNED ADVISORY OFFICIAL BUSINESS U.S. GOVERNMENT	
FSC CODE:			
MDA - LL - 2011 - 001			
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<p>Summary: MDA has experienced various issues with real-time embedded operating systems (OS). Embedded OS tools are typically used in processor based commercial products to shorten development time and provide proven and tested industry standard interfaces and controls to the product in the smallest memory space. Real-time systems also allow for predictable and controllable system response times. It is important for the users of embedded software products to thoroughly test the product to verify the embedded code behaves as it should, and no undesired operations or effects can be triggered. Users must also keep the embedded code updated with all revisions of software and any patches that may be offered by the embedded software company to fix various problems. Failure to do so can often lead to operational problems with the product.</p>			
<p>Examples: A problem was identified with the embedded software within a network module used in MDA Sensors hardware. The fault appears isolated to the Wind River operating system, indicated by a resource access bit that does not get cleared properly. A firmware upgrade is being installed to the network module and all spurs, which incorporates a change from Wind River to prevent a resource contention issue. This change is necessary to prevent future deadlocks. The problem caused the system to require a hard reset, which took 30 minutes. Similarly, an MDA Target experienced a bootup anomaly in circuit cards using the Wind River Tornado OS kernel. Investigation into the problem traced the issue to a cache hit that was not cleared properly after execution of a subroutine. The problem caused the card to "hang", requiring a reset.</p>			

Counterfeits

- Counterfeit parts found in several programs, and has implemented an agency-wide process (e.g. MDA Policy Memo #50) to combat the problem
- Not just Integrated Circuits, but diodes, transistors, chip capacitors, and COTS hardware items have been found to be counterfeit
- Most practical first step is to beef up procurement practices to avoid likely sources and increase awareness to detect them at incoming inspection



Watch where you buy!

**DO NOT
PROCURE FROM
NON-APPROVED
SOURCES!!**

World of Component Sources

***OEM Authorized
Franchised Distributors***

**PREFERRED
PROCUREMENT**

***Prime Approved
Sources***

Reality of Independent Distributors

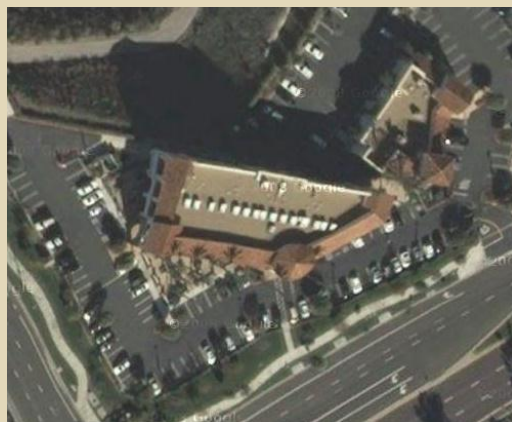


Website photo



Actual “facility”

Both distributors sell (sold) to defense contractors. Both advertise availability to thousands of components. Both are residential businesses.



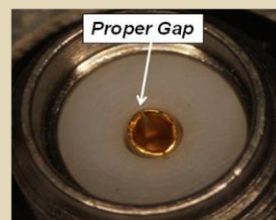
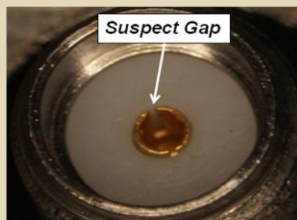
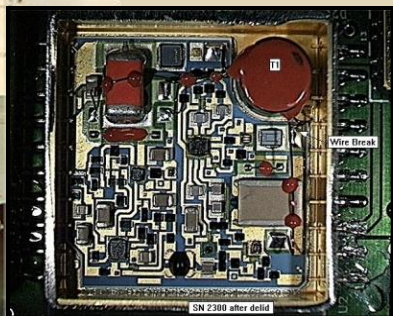
Website address



Actual “facility”

Part Failures

- No matter how hard you try, part failures happen, often because of seemingly innocuous reasons
 - Chip capacitor failures because the sintering oven experienced a power glitch at the factory (process control)
 - Power supply failure due to a tiny transformer breaking loose inside a hybrid. The epoxy pre-form used to glue it down was found to be contaminated by mishandling with silicone
 - SMA jacks with intermittent signal loss found caused by a bad batch of poorly formed center contact barrels making it into finished product



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- As Integrated Circuits shrink to ever-smaller geometries, sensitivity to Electrostatic Discharge (ESD) is a continuing problem
- Pink Poly is not that good
- Moisture sensitivity on small parts forces tighter humidity controls – too low and ESD becomes catastrophic, too high and sensitive devices pick up too much moisture prior to assembly on boards
- Worker awareness and training, MSD tracking processes more important than ever



FOD

- Sensitive parts that must be assembled in clean areas demand a robust Foreign Object Damage (FOD) program
- Shop cleanliness:
 - condition of floors, ceilings
 - We have found crumbling ceilings, broken floor tiles, falling insulation in FOD-sensitive assembly areas
 - clutter, wire clippings, solder splashes
 - tool condition
 - Flaking chrome plate, rust, tape residue on scissors
 - hand lotion (silicone contamination)
 - Sorry ladies, but most hand lotion has various silicones (often Dimethicone) in it



Defective Titanium

- Critical materials are occasionally a tempting thing to take shortcuts to save money or increase profit
- Titanium billet supplier was skipping a couple process steps to reduce cost on billet (an intermediate form of metal)
 - Was not rolling it to spec size, was cutting it
 - Was not performing spec heat treatment
- Resulted in potentially reduced material strength of titanium going into making aerospace parts



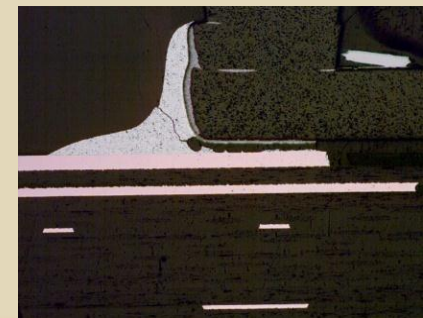
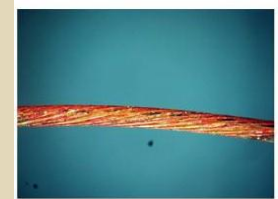
Design Flubs

- A lanyard pull connector failed due to the way the lanyard was oriented and the length of the lanyard
 - Resulted in pulling a connector off the hardware
- Shut-off switches poorly positioned, too close to where operators were resting their hands
 - Equipment accidentally shut off during test
- Need to carefully review design choices to make sure designs perform as intended


Materials Issues

that won't just go away...

- **Tin Whiskers**
 - Pure tin plating, plus Zinc and Cadmium plating, will whisker given enough time – awareness and mitigation
- **Red Plague**
 - Silver plated wire will be destroyed by red plague (copper galvanic corrosion) given time, moisture, and plating damage
- **Silicone and Loctite Migration**
 - Silicone lubricants never cure, and creep and migrate to virtually any surface – avoid use where it can cause issues
 - Loctite (thread lock compound) does not cure, and creeps to unwanted areas – wipe off excess
- **Gold Embrittlement** – solder will become brittle if mixed with gold from gold plated pads
 - Remove 95% of gold from pads prior to soldering by tin/remove process



Embedded Software

- 
- Embedded operating systems and firmware often has bugs and glitches that even the originating supplier doesn't know about until users discover them
 - Real-time OS vendor patches for a popular OS product number into the dozens
 - Make sure you implement all appropriate patches and thoroughly test the deployable code in the product
 - A GPS vendor had a glitch in firmware that caused the time code to skip – once every few days

Quality is Deceiving

- Watch for references to MIL-SPEC quality, where vendor is only performing some of the steps for QPL, skipping others

Actual
Optocoupler
vendor datasheet

Features:

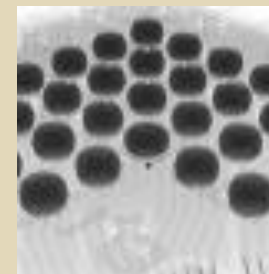
- Processed to MIL-PRF-19500.

devices are processed to military screening program patterned after MIL-PRF-19500.


Dissemination and Control

Processes

- Bonding involves several steps besides applying the glue and putting pieces together
 - Need proper cleaning, surface prep, and testing to assure success
- Soldering still a major source of problems
 - Watch for hidden solder joints and implement proper inspection techniques (x ray, etc)
 - Proper hole fill, tip temperatures, wave exposure time, solder composition, gold removal (gold embrittlement),the list goes on.....
- Carefully design, execute, and monitor all critical processes



Summary

- 
- **Carefully select, implement, execute, and test all processes**
 - **Be wary of where and from whom you procure – there is an ocean of unscrupulous operators out there**
 - **Cultivate a deeper relationship with suppliers, and share company concerns, provide oversight and flow-down of knowledge and requirements**
 - **Spend the extra time and money to sample test and check critical items. It pays dividends by avoiding costly issues later**